# Differentiating and classifying north american wolf-like canids

Environment, Animals

\n[toc title="Table of Contents"]\n

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# Introduction

The endangered species act (ESA) of 1973 is designed to protect critically endangered species in the United States from extinction and therefore guidelines are installed to determine what classifies as a species, however since the ESA's initiation there have been two amendments in 1978 and 1996 (Endangered Species Act 1973). The ambiguity of species classification under the ESA and the advancement of genetics has raised questions into what determines a species, this is particularly prevalent in North American canids (Serenari, Cobb & Peroff 2018).

There are currently three species of wolf-like canids listed under the ESA: The Red, Gray and Mexican wolf (Wozencraft 2005). The Red Wolf (Canis rufus) was nearly driven to extinction in the 1950's due hunting and was listed on the ESA in 1967 (Hinton et al. 2003). The Gray Wolf (Canis lupus) was listed under the ESA in 1973 as a subspecies but was reclassified as its own species in 1978 following the amendments (Paquet & Carbyn 2003). The Mexican Wolf (Canis lupus baileyi) is a subspecies of Gray Wolf and is the most endangered subspecies since it was listed in 1976 due to extirpation

(Mech 1981). There are several other wolf-like canids restricted to North America, four of which are currently recognized as subspecies to the Gray Wolf (Schweizer et al. 1016): The Artic Wolf (Canis lupus arctos), the North-Western Wolf (Canis lupus occidentalis), the Great Lakes Wolf (Canis lupus nubilus) and the Eastern Wolf (Canis lupus lycaon). The Coyote (Canis latrans) is the other wolf-like canid present in North-America.

Researchers are using an array of aspects to explain the evolutionary history of North-American canids including: Morphology, behavior, ecology and genetics. Using these findings and various hypotheses this review will: discuss the evidence in which North-American canids are classified into species, the conflicting theories proposed by researchers to explain the between species hybridization and the recent evidence of hybridization with domesticated dogs. This review will attempt to persuade the reader of which canid taxa should be preserved and will inform of the broader relevance of this novel North American experience. Evidence on number of wolf species. The Red and Gray Wolf are currently recognized as the two-wolf species occupying North America stated by Mammal species of the world, a standard for mammalian taxonomy (Wozencraft 2005). It is also recognized that the Gray Wolf has five subspecies and the Coyote a separate wolf-like canid (Wozencraft 2005). The canids of North America can be distinguished by morphological features.

The pronoun differences in each of the subspecies can be attributed to the ecological differences in their preferred habitat, Chambers et al. (2012) mapped the historic distribution of these species in Figure 1 below. Gray

wolves are the largest canid occupying North America whom diet consists of large hoofed mammals (Mech & Boitani 2003). The Red wolf is smaller than the Gray thus eat smaller mammals, and as per their name they can also be distinguished by their red, tawny color (Gable et al. 2018). The Coyote is the smallest of the canids, feeding off small mammals and fruits (Cypher et al. 2018). Each of the five Gray wolf subspecies can also be distinguished by morphological features. The Artic wolf is smaller, with a white color and narrow skull suitable for hunting small artic mammals (Mech 2007). The North-Western wolf is the largest of the subspecies with a larger head and thick obtuse muzzle which feeds on hooved mammals like the Gray wolf in British Columbia (Smith et al. 2000). The Great Lakes wolf has similar morphology but is 25% smaller and has a greater range of coat color and feasting on small mammals in the western Great Lakes region (Koblmüller et al. 2009).

The Mexican wolf is the smallest of all Gray wolves with a smaller, narrower skull found in Arizona and New Mexico (Odell et al. 2018). The Eastern wolf has shorter legs and is similar in size to the Red wolf roaming the South-Esat Canadian border (Theberge & Theberge 2004). The Coyote was historically restricted to the Western half of the continent, however the deforestation and urbanization that lead to the decline in Red wolf numbers has allowed the Coyote population to migrate East (Wells 1978). Although morphologically and ecologically different, there are theories present that suggest the migration of the Coyote East has led to the hybridization of the Red wolf and Coyote.

## Hybridization between species

There is evidence suggesting and opposing the theory that hybridization has occurred between: Red wolves and Coyotes, Gray wolves and Coyotes, and Eastern wolves and Coyotes. It is believed that the migration of Coyotes eastwardly, and the reduction of the Red wolf habitat lead to Coyote introgression into the Red wolf population (Fener et al. 2005; Levy 2012). This is rebutted by Hinton et al. (2015) who noted that Red wolves that did not pair with other Red wolves would preferentially pair with admixed individuals rather than Coyotes. This is supported by Gese & Terletzky (2015) whom states that Red wolves regularly killed or displaced coyotes forming a potential reproductive barrier between the two species.

The behavior of Red wolves towards Coyotes is similar of Gray wolves according to Rutledge et al. (2012) where they found they also often kill Coyotes and they state no mating between the two species had been reported in the wild. This is disputed by Mech et al. (2014) whom conducted an artificial insemination experiment concluding that Gray wolves are not completely incompatible reproductively with Coyotes as one in nine female inseminated produced offspring. A principal component analysis of 48 000 SNP’s (Figure 2) conducted by vonHoldt et al. (2011) that Red wolves are the most genetically distinct of the three species, with a clear genetic distinction between Gray wolves and Coyotes. Hybridization between the Eastern wolf and the Coyote is well documented and is theorized that Eastern wolves are a hybrid formed by Gray wolves mating with Coyotes. Wheeldon et al. (2010) found that Coyote mtDNA was present in Eastern wolf but Coyote Y-

chromosome haplotype was absent, suggesting male Gray wolves were mating with female Coyotes. Wilson et al. (2012) suggest that male-mediated introgression of the Gray wolf genes via the Eastern wolves as they found Eastern and Gray wolf Y chromosomes present in the Coyote.

Most recently however, researchers been analyzing the possible hybridization effects of domestic dogs with wild North American canids. Although it remains controversial, it is evident that the dog was domesticated from a wolf-like canid as its closest relative is the Gray wolf (Zhenxin et al. 2016). Researchers have previously attempted to analyze whether dogs have been breeding with wild canids however this has proven difficult as Gray wolf genes are very similar to domestic dog genes (Federoff & Kueppers 2000).

Anderson et al. (2009) conducted a study on the melanistic gene that gives canids a black coat, it is common in domestic dogs due to human artificial selection and is thought that domestic dogs passed this trait onto wolves. Black coated wolves occur more frequently in forested habitats (62% of population) in comparison to icy tundra biomes (7%) (Anderson et al. 2009) in which researchers concluded this gave forested populations an adaptive advantage. This association with forested habitats means the prevalence of melanism should increase as forests expand northwards (Anderson et al. 2009). This is one example of a possible hybridization effect between dogs and wolves, where the preserved genetic diversity from domestic dogs can be passed onto wolves to aid an adaptive advantage. In contrast to this, it has been stated that behavioral traits from domestic dogs could prove a

disadvantage if passed onto wolf like canids. If inherited, canids could face an increased mortality rate as an added compliance to humans would increase the risk of decease to hunters (Treves et al. 2017). Although it is difficult to analyze, wolf-like canids could both benefit and detriment from hybridization with domestic dogs.

## Conclusion

There is a growing amount of research focusing on wolf-like canids in North America which allows the author to hypothesize on the lineage and evolution of these mammals. The author believes that there two species of canids, the Red and Gray wolf, with the Gray wolf composing of five subspecies. The author also reasons that due to morphological features, hybridization has not occurred between Red wolf and the Coyote and is a stand-alone species, it is also speculated that Gray wolf and Coyote hybridization occurred to give rise to the Eastern wolf. In respect to which canids should be conserved and listed under the ESA, the author believes that any endangered canid of North America should be protected from extinction and those currently listed should remain so.

The believes that preserving different lineages, regardless of evolutionary origin will retain and promote the upkeep of genetic diversity in North American canids in a vastly evolving landscape with the urbanization of America (Cai et al. 2019) and the changing biomes due to global warming (Gholz & Blood 2016). This novel experience that researchers are facing in North America can be translated to other parts of the world. The endangered Western Barred Bandicoot in Australia was reintroduced into South Australia

with researchers claiming that it was five distinct species rather than one unique one (Travouillon & Phillips 2018). The author recommends when facing species lineage problems that the reader considers various aspects; behavior, morphology, ecology and genetics are all equally important factors in determining whether an animal is one species of multiple.